THE

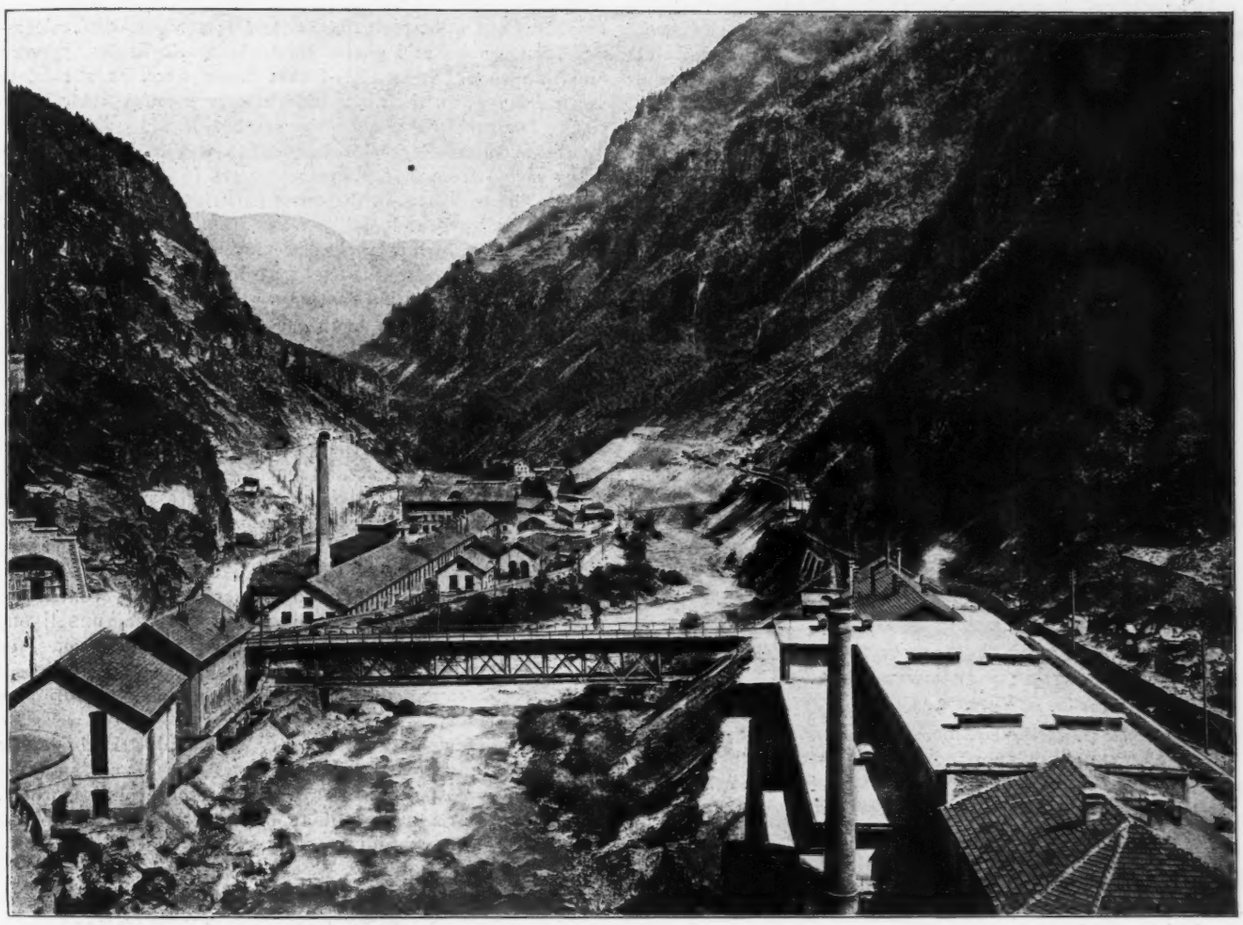
Journal of Electricity, Power and Gas

WITH WHICH IS INCORPORATED

The Engineers' Architects' and Builders' News

VOLUME XVII. SAN FRANCISCO, CAL., SEPTEMBER 29, 1906 No. 13

The Electrical Power Installation for the Simplon Tunnel



THE ELECTRIC POWER INSTALLATION FOR THE SIMPLON TUNNEL.

The completion of the Simplon Tunnel has been duly celebrated by the Milan Exposition, under the patronage of the King of Italy, and there is great interest at the present time in the electrical equipment which is utilized for hauling the heavy trains through this, the longest tunnel in the world. The tunnel passes through the Alps, one entrance being at Iselle, in Italy, and the other at Brigue, in Switzerland.

The electric locomotives in operation were constructed by Brown, Boveri & Co., of Baden, Switzerland, jointly with the Schweizerischen Lokomotivefabrik, in Winterthur, Switzerland, as well as Ganz & Co., of Buda Pesth, Austria, electric locomotives of the latter firm having been used extensively on the Valtilina Railway in Northern Italy.

The accompanying illustrations show the stations and hydraulic apparatus, as well as the electrical equipment at the two power stations at Brigue and Iselle.

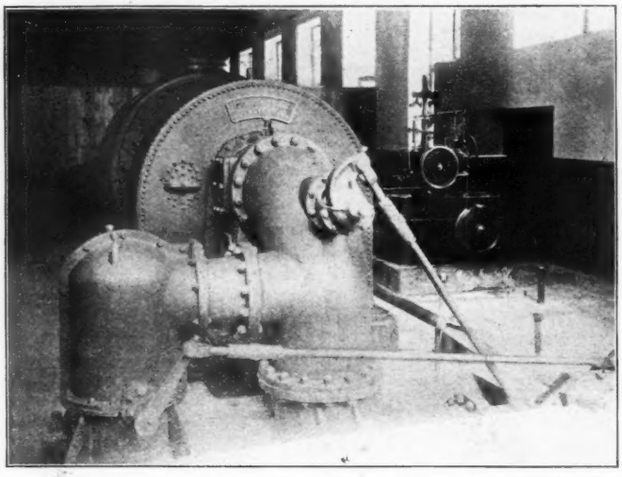
At the Brigue power house the turbines were installed by Escher, Weiss & Co., of Zurich, Switzerland, and are similar in design to those recently built for the British Aluminum Co. of Foyers, N. B. (Scotland), the latter, however, operating under a head of 100 meters (330 feet), with a speed of 150 revolutions per minute, and developing 780 horsepower. These turbines are equipped with governing apparatus, while those at the Simplon station at Brigue are not so equipped. The Brigue turbines at the Simplon tunnel operate under a head of from 45 to 55 meters (150 to 180 feet), developing 600 horsepower each, with a speed of 160 to 170 revolutions per minute.

The water is received through large pipes, 1,600 millimeters (62 inches) in diameter, from the River Rhone, and to each of the two turbines installed at this power house is directly coupled a three-phase alternator, supplying a current having a frequency of 60 cycles per second, and a pressure of 3,000 volts. The steel revolving fields of these generators constructed by Brown, Boveri & Co. have 12 pole pieces, all cast in one piece, this great flywheel having laminated iron portions held firmly in place.

The exciter dynamos at the Brigue power house are of the Oerlikon type, and were formerly used for lighting the tunnel during the construction period. These direct current

dynamos operated at a speed of 500 revolutions per minute, and supply a current of 520 amperes at 125 volts pressure. The iron core of the armature is 520 millimeters (20.3 inches) in diameter, and 440 millimeters (17.2 inches) in length. It is provided with 100 slots, each containing two copper conductors, having a section 2.2 millimeters by 20 millimeters (.085 by .8 inches). The field coils are shunt wound, the four spools of the magnet having 539 turns of copper conductor 2.9 by 3.4 millimeters (1.13 by 1.32 inches) for the shunt winding the three conductor windings for series connections being copper bands 3.5 by 90 millimeters (.136 by 3.5 inches).

The current is conducted from the Brigue power house to the tunnel by overhead conductors at a pressure of 3,000 volts, and is utilized by the electric locomotives directly at this pressure, all of the necessary transforming apparatus and controlling devices being mounted on the locomotives themselves.



TWO-750 H. P. TURBINES COUPLED TO 3000 VOLT ALLEMATOR AT THE ISELLE POWER PLANT.

The Iselle power house, located at the Italian entrance to the Simplon tunnel, is supplied with water from the Diveria at a pressure of 14 atmospheres (260 pounds) through a system of pipes 900 millimeters (35 inches) in diameter.

The Iselle power house is equipped with turbines constructed at Geneva, Switzerland, by Pictart, Pictet & Co. These turbines operate at a speed of 960 revolutions per minute, working under a head of 140 meters (458 feet), and developing 750 horsepower each, or a total of 1,500 horsepower for this plant. These turbines are also directly coupled to an alternator supplying three-phase current of 60 cycles per second, and 3,300 volts pressure. The current is transmitted from this station to the tunnel feeders, the current passing from the overhead trolley lines in the tunnel, through the locomotives and returning through the track. On the north side the conductors are mounted 5.2 meters (17.5 feet) above the track, while on the south side the height of the conductors is 5 meters (16.4 feet), and in the tunnel 4.8 meters (15.75 feet).

During the construction of the Simplon tunnel, the greatest undertaking in tunneling up to date, the Brandt hydraulic rock drill was exclusively used for the north as well as for the south side.

It will be noted that this tunnel connects the railway system of Western Switzerland with that of Northern Italy, and has a length of 19,770 meters (12.27 miles). The northern entrance of the tunnel in the Rhone Valley at Brig, lies 686 meters (2,250 feet) above the level of the sea, while the south entrance in the Valley of the Diveria, beyond the Italian border, is located 634 meters (2,040 feet) above sea level. The inclination of the tunnel on the north side is 20 feet in 1,000 feet, and on the south side 70 feet in 1,000 feet.

During the construction on either side two separate headings 17 meters (55 feet) apart were driven, which were connected with each other in intervals of 200 meters (656 feet) by cross galleries cut at an incline to the axis of the tunnel.

It is said that on the north side three drills were at work at each heading at the same time, and during the first few years also three on the south side. Later, however, on account of the unfavorable position of the strata, four heavy type drills were used per heading.

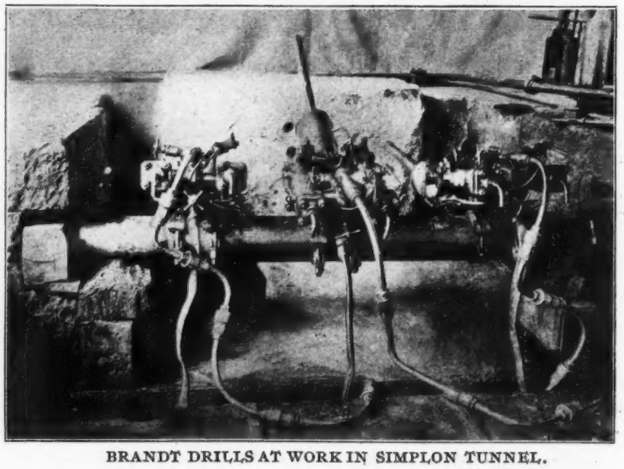
The hydraulic rotary drills were furnished by Sulzer Bros., of Winterthur, Switzerland, and rock of very different character had to be pierced, grey and calcareous shist, micareous shist, gneiss and gneiss shist, Antigorio-Gneiss, gypsum and limestone. It is stated that these were, as a rule, in vertical layers on the north side, and very unfavorable, practically horizontal, strata on the south side.

The section of the heading which was to be cut by the drills varied from 6 to 7 square meters (64.5 to 75.25 square feet). The rack bars in the cross galleries, which latter were also driven by Brandt drills, were often placed in a vertical position. The hydraulic pressure for working the drills was from 7.5 to 8 atmospheres, or 110.2 to 117.7 pounds.

During construction the power plant and machinery outside of the tunnel was, with the exception of a few details, practically the same on both sides. On the north side the water for the turbines was taken from the Rhone, while the Diveria supplied the water power on the south side, the water being taken at a point 4 kilometers (2.5 miles) above Iselle.

On the north side the plant consisted of four Pelton water wheels with horizontal shafts, producing a total of 1,500 brake horsepower for driving the high pressure pumps and the air compressors for the air locomotives, two turbines each having a maximum capacity of 200 brake horsepower, for driving the large fans; two turbines each of 300 brake horsepower coupled direct to two Sulzer high-lift centrifugal pumps for supplying the cooling water to the tunnel; one turbine of 100 brake horsepower and two smaller ones for driving dynamos and the machine tools. In addition, three semi-portable steam engines of 60 to 80 horsepower were provided as a reserve.

The pumping station at Brig, to supply the hydraulic pressure for driving the drills, tunnel fans, and spraying apparatus, consisted of six twin high-pressure pumps, which, together, gave an output of about 46 litres (1.6 cubic feet) per second, at a maximum pressure of 12 atmospheres, or

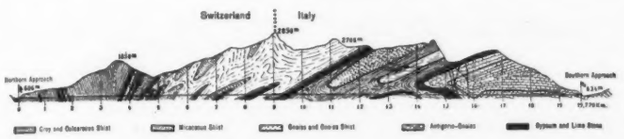


BRANDT DRILLS AT WORK IN SIMPLON TUNNEL.

176 pounds. This pressure was fed to a common collecting pipe of 150 millimeters (5.8 inches) diameter, from which two separate mains of 100 and 120 millimeters (3.9 and 4.7 inches) diameter led to the tunnels. For regulating the pressure two weight accumulators were provided.

The main ventilating plant on either side of the tunnel is fitted with two centrifugal fans, the diameter of which is 3.775 millimeters (12 feet), the diameter of the two suction nozzles being 1,250 millimeters (4 feet). This arrangement allows of various combinations for working. When coupled for quantity, the two fans can supply to, or draw from, the tunnel 50 to 60 cubic meters (1,762 to 2.120 cubic feet) of air per second. The arrangement provided in the completed tunnel is such that the set of fans on the one end blows and the other set draws the air through the tunnel.

Until the junction of the north and south headings, the air was led through tunnel No. II, and thence through the last cross gallery to tunnel No. I, which latter served as return conduit. For ventilating the working face, for the distance



behind the last cross gallery, spraying devices were employed, which were inserted and connected in series in 400 millimeter (15.6 inches) piping, and which supplied about 120 cubic meters (4,240 cubic feet) of air to each heading, or 6 cubic meters (212 cubic feet) of air per minute for each miner.

In order to overcome the high temperature on the north side (at the eighth kilometer, fifth mile, a temperature of 55 degrees centigrade was found), two Sulzer high-lift centrifugal pumps driven direct by two turbines were installed. The pumps, when coupled in series, delivered 80 liters (3 cubic feet) of cold water at a maximum pressure of 4.4 atmospheres (65 pounds) to the air cooling plant in the tunnel. The excavations for the foundations, when putting down the bade lining, were drained by water jet pumps.

The Brandt drills built by Sulzer Bros. were first used on the north side on December 1st, 1898, after 190 meters (623 feet) had been driven by hand. On December 1st, 1903, the length of the heading on the north side was 10,150 meters (6.3 miles). The time specified for completing the main heading—five years—was thus complied with on the north side, the required length being exceeded by 265 meters (870 feet).

The work on the south side was delayed by the influx of large quantities of water, sometimes as much as 1,200 liters (42 cubic feet) per second, and also by the disintegrating property of the material as well as by the unfavorable practically horizontal strata. The most favorable week gave a progress of 63 meters (207 feet), or 9 meters (30 feet) per day, this being accomplished while working on the south side.

THE COLOR OF LIGHT IN ITS RELATION TO ILLUMINATION.

There have been many discussions lately, says R. G. T. in the Electrical Review of London, on the subject of light, the relative value of gas and electricity, the proposed standardization of electric lamps, etc., and I have been much struck by the absence of any exactness or definiteness as to what light should be. In nearly all these discussions the value of light is regarded on the basis of the quantity or intensity only of the light given by each illuminant, the quality being always ignored or dealt with in quite a cursory manner. The efficiency of electric incandescent lamps, "open," "enclosed" and "flame" arc lamps, Nernst and mercury vapor lamps, are all discussed in similarly unsatisfactory style.

Surely it is possible to determine what is useful light, and to obtain an authoritative dictum as to what is best suited for the human eye.

It is commonly stated that what we want is white light, and each lamp merchant claims to have produced a counterfeit of or improvement on the sun. White light is, of course, a compound, and what we want is an authoritative decision as to which primary color or combination of primary colors is required for human use. I was surprised to hear Mr. Swinburne say at the Electrical Exhibition that probably the best quality of light for home use would be obtained from numerous coal fires dotted about our rooms, but that it would be the most costly. Well, the best generally is the most costly, and the practical man was created especially for the purpose of finding the nearest approach to the desirable at a practicable price. It is no use saying that you can get larger quantities of green or blue or yellow light at a cheaper price, though, of course, if you get enough bad light, it will serve after a fashion, as there will be enough red light contained therein to enable you to see; and, in my opinion, it is the use of glaring lights of improper color that occasionally punishes the eyes so by reason of the fierce reflection from all white surfaces, and makes one wish for two or three tallow candles for a treat. Therefore, neither quantity nor quality must be neglected when comparing values.

I say I was surprised to hear Mr. Swinburne say that light ought to be red. I always thought so, but did not think it was scientifically settled that way. I was surprised again when he discussed the mercury lamp, and said that as it was so deficient in red rays, it was very restful to the eyes. This, I think, can only be true in a certain sense. If you give up trying to work or read by it, of course, it is restful, but you can do this to still better effect, probably, in total darkness.

In regard to the useful life of incandescent electric lamps, it is often stated to be best to overrun them, getting a largely increased quantity of light for a shorter life, and recent tests show that (on a quantitative basis only) this will pay when lamps are over-volted to an extent that will correspond with a consumption of power of 1.5 watts per candle-power. All this I fervently disbelieve. The light is much too "white," i. e., deficient in red rays, approaching the color of the "highly efficient" open arc lamp, and suitable only for open-air treatment and for decorative purposes. The matter than resolves itself mainly, I believe, into a determination of the correct degree of incandescence permissible, and it would appear that nearly all materials are capable of being raised to such a temperature that the emitted light is useless for lighting purposes. If you hustle sufficient gas through a burner by compression you can get enough light from a "Welsbach" to frighten the most hardened electrician. Whether the extra cost of gas and mantles is "worth the candle" is what I want to know. My belief is that the effect is precisely the same as the over-volted incandescent electric lamp and some arc lamps, the light being decorative but useless.

Standardization and comparison of lights then should start with a determination by spectrum analysis of the constitution of the light emitted by the incandescence of each material, and this I am confident would lead to the immediate rejection of many lights that are now in use to the detriment of our eyesight. Incidentally, I think we should arrive at a more satisfactory understanding of the relative values of electricity and gas.

San Francisco, Cal.—The special commission of engineers appointed several months ago to pass upon the various plans for securing an adequate water supply for San Francisco has resigned. The members of the commission, which was composed of Major C. H. McKinstry, Professor A. B. Marks of Stanford University and F. Hunt of San Francisco, tendered their resignations to Mayor Schmitz several days ago.

Fourteenth Annual Convention of the Pacific Coast Gas Association

Continued from Page 231

PRESIDENT'S ADDRESS.

To the Officers and Members of the
Pacific Coast Gas Association:

Gentlemen: It has been the custom of my predecessors to say a few words to you at the opening of your annual session, and I had sincerely hoped to have had the pleasure of doing so in person, and particularly at this meeting when we are all filled to the brim with new and varied experiences of an unusual character through which we have passed during the preceding six months, and in this glorious city the most serious conditions prevailed as a result of the greatest conflagration known to history.

I will not dwell at length upon the sad story, of which so much has been written and of which so much has been falsely represented; but even the most prejudiced and distorted mind did not fail to record the innumerable acts of bravery and the superhuman determination and resolution of our citizens in San Francisco to rebuild better and grander than before.

Some of our members played a very important part in San Francisco, not only during the conflagration but ever since, and I know that the members in attendance will receive an education and a fund of knowledge from them, which will prove not only of material value to you, but will demonstrate to the world at large what men can do under almost impossible conditions; and to these men our unstinted praise is due as a fitting reward for their heroism.

I leave it to them to tell you in their individual way of the great obstacles surmounted and the achievements accomplished, and I hope it will be as a lesson to all should such a misfortune ever visit other localities.

The experiences which will be related will demonstrate relatively how little damage was done by the earthquake in comparison with the great fire damage, and the testimony presented will be unimpeachable.

At the last meeting of our Association I had the pleasure of presenting a descriptive paper of a gas engine power plant then being installed. The plant is now very near completion, and an opportunity will be given to you all to visit it. It is hoped that in your visit to the gas engine station of the California Gas and Electric Corporation one of the gas engines will be ready for operation, and its successful completion will mark one of the greatest strides in the advancement for the proper utilization of gas which has been known to this generation.

I hope that each and every member present will feel that he is an integral part of this institution, and that his voice will be heard—even if only to ask a question. You must remember that our greatest minds frequently receive their most valuable suggestions from their assistants who are actively on the firing line and who come more immediately in contact with the troubles and the necessities for their correction.

It is with sadness of heart that I address these few lines of encouragement to you, but for reasons beyond my control it is necessary to be absent from our beloved city during the time of your meeting, and I know that you will accept my apology for this enforced absence with the full knowledge that no personal sacrifice would be too great for me to make to be with you.

I bespeak for this meeting the continuation of harmony which has prevailed so delightfully in the past, and that good fellowship will continue to reign supreme. The lessons inculcated and the renewal of friendships developed and strengthened, will send you back to your homes the better fit to guide and direct the affairs of your companies for their greater success and for your greater advancement.

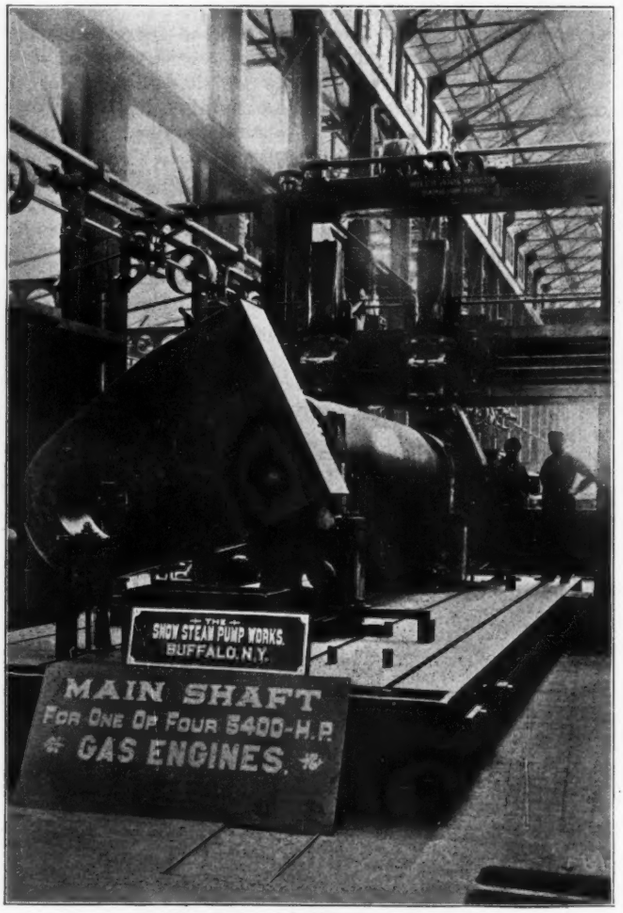
Sincerely yours,
JNO. MARTIN.

LARGE GAS ENGINES FOR POWER PURPOSES.

Gentlemen: The progresses of the large gas engine must be of considerable interest to the members of your organization, especially as prime movers for power station, where the gas company also furnishes electricity.

Although Otto introduced the 4-cycle gas engine twenty-three years ago, the progress made was at first slow, as the 4-cycle was protected by patent. During this time, a large number of 2-cycle engines were designed and constructed, but when in 1886 some of the patent claims were declared void, and the 4-cycle became public property, most of the 2-cycle constructions disappeared again.

As some of you may not be familiar with the exact meaning of the terms 2-cycle and 4-cycle, it may be well to explain the same. In a 4-cycle engine the cycle is completed in 4-strokes—the suction, compression, expansion and



CRANK SHAFT, 5,000 H. P. ENGINE

exhaust stroke. During the suction stroke, air and gas are drawn into the power cylinder, in such proportions as to form the best possible explosive mixture. The piston then returns and compresses the charge which is ignited at the end of the compression stroke. The increased pressure drives the piston forward on the expansion stroke, at the end of which the exhaust valve opens, permitting the burnt gases to escape during the exhaust stroke. Evidently there is one working and three idle strokes. These remarks refer only to single acting engines.

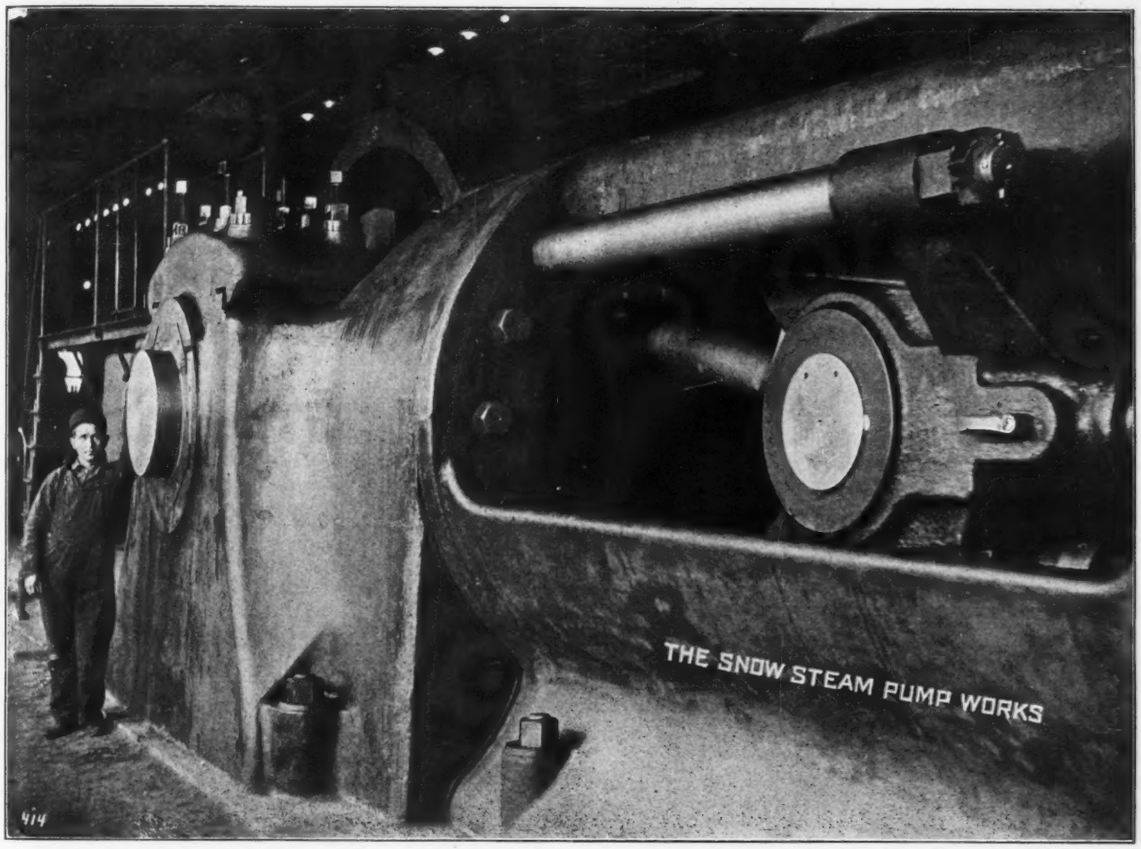
In a 2-cycle engine, the charge is forced into the power cylinder by a gas and air pump and are proportioned so as to give the right explosive mixture. The charge is then compressed by the power piston, ignited near the end of the compression stroke and expanded on the next stroke. Before the piston reaches the end of the expansion stroke, it uncovers the exhaust ports which are located in the cylinder walls, permitting the burnt gases to escape at the end of the stroke. The new charge is then again pushed into the power cylinder by the gas and air pump, through an inlet valve as in the Koerting engine, or through port openings, opened and closed by piston, as in the Oechelhauser engine. The incoming charge displaces the remaining exhaust gases.

The principal objection to the 2-cycle engine is the excessive pump work which reduces the mechanical efficiency very much below that of the 4-cycle engine and increases the fuel consumption.

The development and introduction of the large engine has been quite rapid in Europe, and started well with the installation of eight 1,000 and sixteen 2,000-horsepower gas engines at the Lackawanna Steel Company, Buffalo, but after this, engineers and capitalists began to wait for developments. An encouraging exception was made by the natural gas industry in the East, where the Snow Steam Pump Works of Buffalo installed fourteen 1,000-horsepower, two 4,000-horsepower, and some 500-horsepower engines for pumping natural gas from their low pressure wells into their high pressure delivery mains. The pressure is generally about 300 lbs. in the delivery line, and is generally below 100 lbs., sometimes only a few pounds above atmospheric pressure. The rock pressure is in some places 1,300 lbs. The two 4,000-horsepower pumping engines at Hastings are the largest gas engines in operation, and will only be surpassed by the four 3,530-horsepower gas engines built by the Snow Steam Pump Works for the California Gas and Electric Company of San Francisco. Three of these engines are nearing their completion at the San Mateo power station, while one will be erected in Oakland, Cal. A description of some of the details may be of interest to you.

The engines will be direct connected to 4,000 kilowatt Crocker-Wheeler 25 and 60-cycle alternating generators, 13,200 volt, 88 revolutions per minute.

Each engine will have four double acting 4-cycle power cylinders. The cylinders are made in two parts, with a cir-



MAIN FRAME—400 H. P. ENGINE

cumferential joint in center, which will be covered by the removable part of the water jacket. The water jackets on end of cylinder are cast with the same. The explosion chamber is cast to one side of cylinder because this gives the strongest casting, and makes the exhaust valve very much more accessible than when placed under the cylinder.

The heads are water jacketed, and provided with removable plugs permitting of inspection of cylinder without removing head.

The stuffing boxes are designed the same as the metallic stuffing boxes for large steam engines. The rings are made of cast iron, as this has been found much superior to softer metals such as babbitt or bronze. There is no danger of heating the stuffing box, as the rods are generally so cool that you can put the back of your hand to it. The wear of a cast iron stuffing box is very small and probably the same as in steam engines.

The pistons are made of cast iron and bolted together on a circumferential joint. Six concentric cast iron piston rings, without keepers, are used.

The piston rods are 15 inches in diameter and made of two parts, the sleeves made of nickel steel and the bolt, which extends through the whole length of piston and sleeves. No screw joint nuts, keys, etc., are used inside of cylinder where the sleeves butt against the piston. The pistons and rods are carried by the main, intermediate and tail rod crossheads, so that the piston can not wear on bottom of cylinder.

The power cylinders are supported on the bedplate in such a way that they can slide in grooved guides in the longitudinal direction only to allow for expansion or contraction caused by change in temperature. The bedplates are held solid down to the foundation with foundation bolts.

The weight of the crank shaft is 99,734 pounds, diameter of flywheel, 27 inches, journal bearing 2 feet 6 inches by 4 feet 8 inches, crank pin bearing 19 inches by 19 inches.

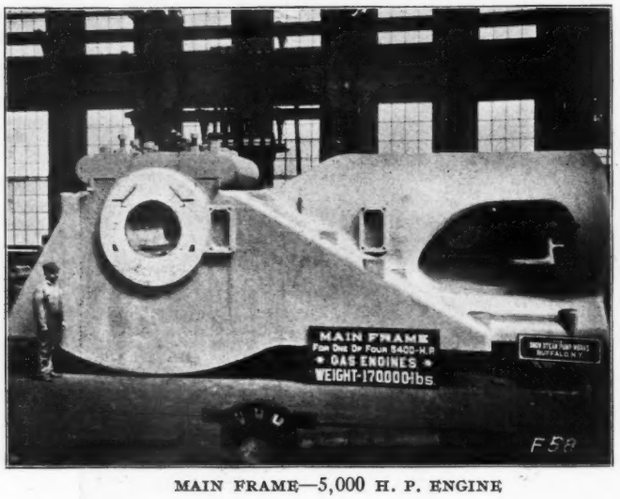
The design follows the steam engine practice by using two overhung crank pins, and avoiding the trouble to keep more than two main journals on one engine in line. It is a radical departure from the general gas engine practice, but has proved successful and will be used by other builders. The crank arms are provided with heavy counterweights to partly counterbalance the momentum of the heavy moving parts, the pistons with rods, crosshead and connecting rods.

The flywheel weighs 50 tons. This is rather small weight for a large engine, but the weight of the rotor has been considered. To insure parallel operation it has been customary for the electrical form to specify the wheel to be of such weight as to limit the angular displacement from the mean position to 2.5 electrical degrees, but it has been found that lighter wheels, when their weight was chosen correctly, have given better results. When the wheel has not the proper weight parallel operation becomes difficult.

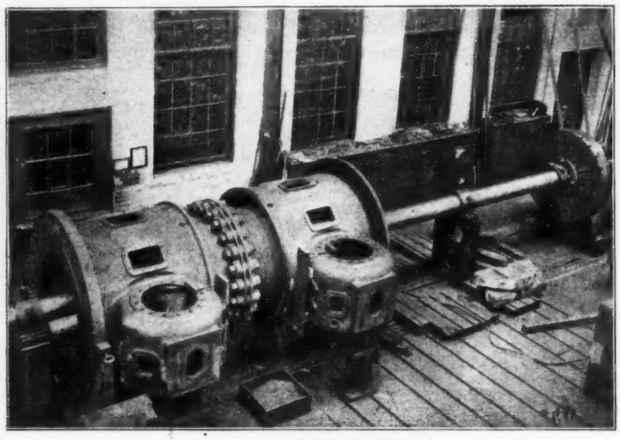
The weight of the main frame is 170,000 lbs. It contains the bored guide for main crosshead and the main bearing.

The inlet and exhaust valves are operated by cams and are water cooled. Their location is such that they are easily accessible.

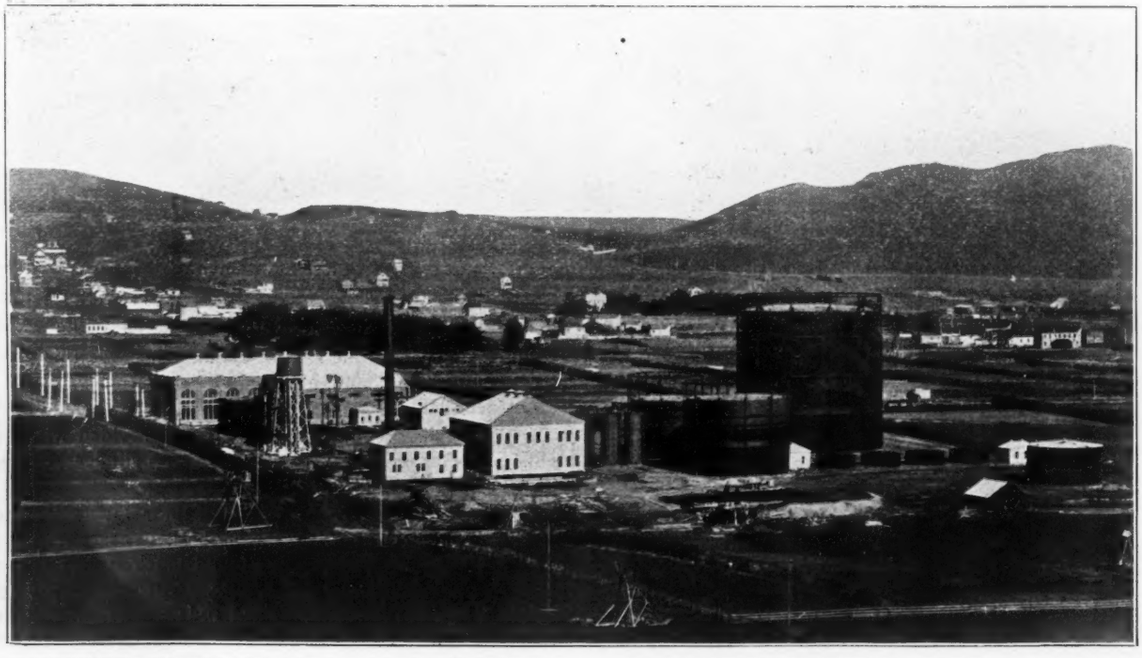
For ignition the electric make and break spark is used in connection with a storage battery. It requires about 10 volts



MAIN FRAME—5,000 H. P. ENGINE



POWER CYLINDER



Gas Engine Power Plant | Gas Works | Relief 400,000 C. P. | Storage Holders 1,500,000 C. F. | Purifiers | Oil Tank

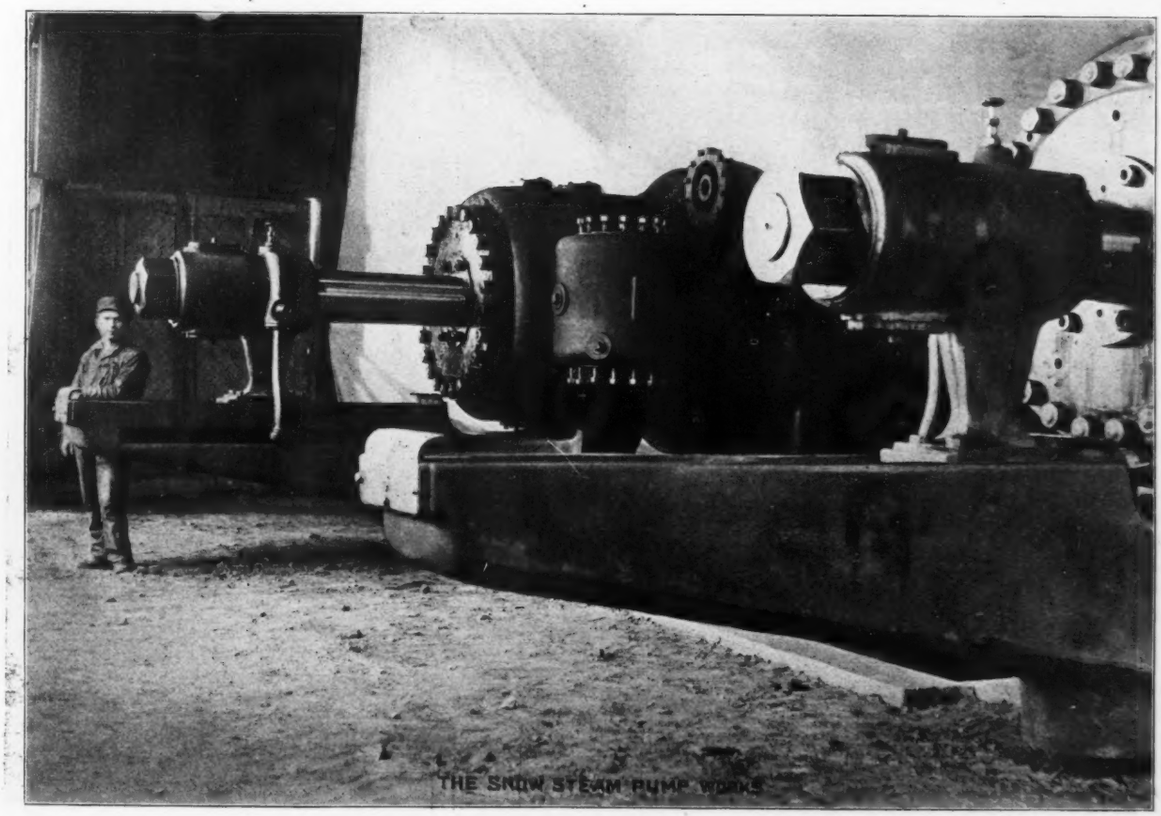
and 1 ampere. Each igniter is supplied with a spark coil and indicator. The indicator will indicate constantly the condition of each circuit. When indicator swings with the igniter the igniter is in order, when it stays drawn up against the core, the igniter is short-circuited, when it hangs motionless, no current flows through the igniter, and we have to look for a poor contact of electrodes unless there is a loose or broken connection.

The engines are started by compressed air through valves which are operated from the cam shaft in such a way that the air enters behind the piston which is starting on its expansion stroke, acting in the same way as steam in a steam engine. At the end of the stroke, the exhaust valve opens and the air escapes. Some of the cylinder ends during this time take in a charge, and when this is ignited the pressure holds the check valve closed so that air cannot enter the cylinder. After a few explosions the air is shut off, and engine will soon gain its full speed.

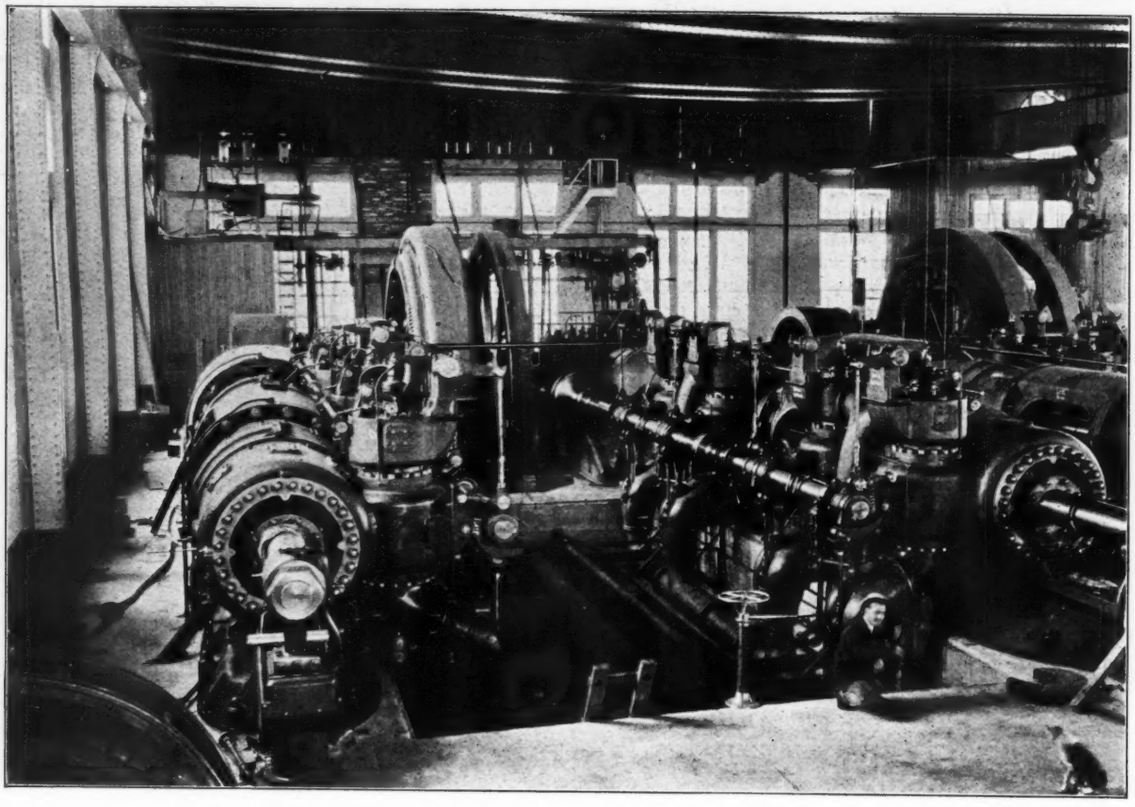
The speed of the engine is regulated by the governor working on the compression and also on the mixture. The Lombard governor is used which regulates indirectly with the aid of pistons moved by oil under pressure. This governor is very powerful, yet still very sensitive, and can be easily adjusted to give a slow regulation which is suitable for parallel operation, or a close regulation for direct current generators. Besides the governor, an independent safety device is employed to stop the engine in case the governor should lose control of it.

Generally two kinds of oil are used for large gas engines, the ordinary lubricating oil and the cylinder oil. Oiling systems facilitate the lubrication of crank bearing, crank and crosshead. The oil is fed to the bearing through sight feeds, is then run through filters and pumped up to the storage tank. The cylinder oil has to be a different quality than the oil used in a steam cylinder. The oil must have a high flash point and must not carbonize. The oil is forced into the cylinder when the oil hole is covered by the piston, and is

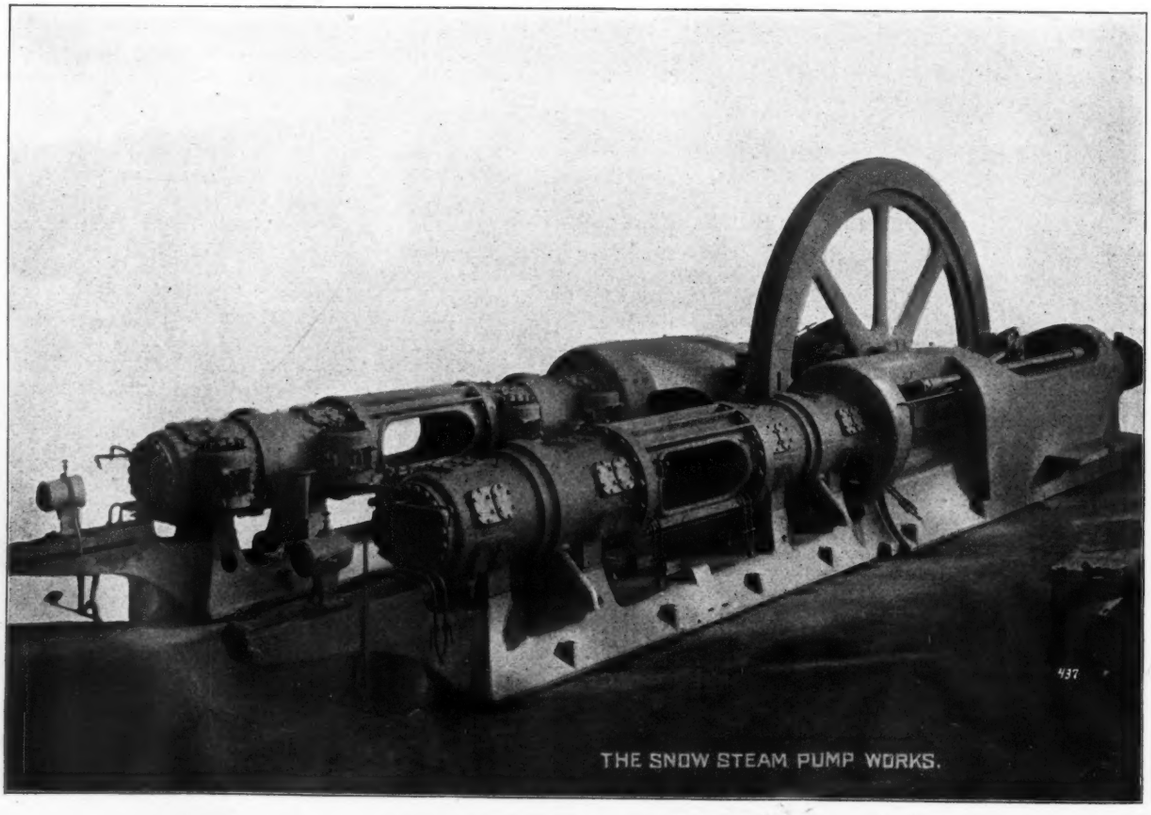
MAIN BEARING CAP, 5,000 H. P. ENGINE



TAILROD END—4000 H. P. GAS ENGINE



5300 H. P. GAS ENGINE



ARRANGEMENT OF CYLINDERS ON FRAME

forced on the piston between the rings. The oiling of the gas engine cylinder is not nearly as difficult as it appears, because the piston is cooled by water. Too much oil causes carbon deposits and is detrimental. When the exhaust from a gas engine is blue, it is a sign that too much oil is used and is burned; black exhaust indicates too much gas. The exhaust should be colorless, but is mixed generally with steam from water injected into exhaust to cool the same.

The superiority of the gas engine over the steam engine in thermal efficiency is well known. The saving in fuel depends on the type of gas and steam engine, while the saving in running expense depends on cost of fuel and on local conditions. Ordinarily the gas engine will use less than half the fuel of a first rate steam engine. In natural gas districts, where no producer is required for the gas engine, but a boiler plant for the steam engine, the gas engine will require less than one-third the fuel. For the smaller engines where the steam engine is generally more wasteful and suction producers are used for the gas engines, the saving may reach 80 per cent or more.

In selecting a power engine, it is well to consider items such as water. Hard water may give trouble in boilers, by forming troublesome scale, but the hardness of the water is of little consequence when used in the jacket of a gas engine as long as the supply is sufficient.

TAR AS GENERATOR FUEL.

At the twenty-ninth annual meeting of the Western Gas Association, Mr. George H. Waring read the following paper on "The Utilization of Tar in Water Gas Apparatus:"

Oil tar was first used as generator fuel in a double superheater reverse steam Lowe water gas apparatus in 1898 by Mr I. N. Knapp, then superintendent of the Omaha Gas Co. It was demonstrated to be such a success that its use has been continued in Omaha up to the present time.

The method of utilizing oil tar as generator fuel, as adopted in Omaha, is as follows:

The tar is freed from all but a small percentage of water by passing it through two separators and from thence in a tar well, where it is allowed to stand for some time. The tar to be used in sets is pumped from the bottom of the tar well into the top of the first condenser, where it is stored previous to being used. As the temperature of the gas passing through this condenser is about 180 degrees, the temperature of the tar is raised to about 130 degrees, and all the remaining water is driven off and hot tar free from water is used.

An analysis of this tar is given below. In the engine room a steam pump, running continuously, draws this tar from the bottom of condenser and maintains a pressure of 30 pounds at the tar meter on generator operating floor. The outlet of the tar meter is connected with two tar nozzles, which are connected into the steam inlets at the top of the 11-foot generator diametrically opposite. The nozzles as shown by sketch are outside of the generator and are subjected to no greater heat than the entering steam. Tar is admitted with steam only on a down run, which is about every third run. The tar is turned on after the steam, and turned off before the steam is shut off. The 1½-inch induction pipe is kept clear and gives no trouble unless the tar is allowed to leak in. Any leak in the tar valve will cause a deposit of carbon at the end of the 1½-inch steam pipe. Carbon deposited in the induction pipe can be removed by taking out the 2x¾-inch bushing, carrying the ¾-inch tar nozzle, and inserting an auger of the same design as that used for cleaning standpipes.

The gas-maker turns on the tar in generator after turning on the oil in carburetter, and turns off the tar before turning off the oil. After turning off the tar, the tar pipe is blown out with steam which is connected at outlet of tar meter. When using tar on down run smoke will be noted at coal-hole doors, but if these doors are kept tight this smoke is not objectionable. A small amount of lampblack will be noticed in ash pit when an excess of tar is used. The valve stem of the water-cooled hot valve accumulates some pitch, and should be scraped off and oiled about once a day to keep it working freely.

After making a down run when using tar there is quite a showing of smoke at the stack valve when generator blast is put on, but it disappears as soon as the secondary air is admitted. Our gas makers do not object to the use of tar in generators. They now look upon it as upon any other of the necessary functions of gas making. No unusual fouling of fixing chambers and no trouble from naphthaline have been noted, due to the use of tar in generators. Nor does it affect in any way the tar being made.

After using over 1,000,000 gallons of tar in our generators in the past seven years, thereby making a saving of over 4,000 tons of coke, we are able to give the following results as to the value of tar as generator fuel. We have been using tar with more or less success in varying quantities from .3 to 1 gallon per 1,000 cubic feet of carburetted water gas made. Our experience has been that we cannot use over .5 gallon per 1,000 efficiently when using oven coke, and .4 gallon when using gas coke, except when making more down runs than every third run. When making fewer down runs than every third run a proportionately less amount should be used. After repeated tests under similar conditions, with and without the use of tar in our generators, we find that the average value of a gallon of tar free from water is equal to 8 pounds of New River or Pocahontas 48-hour oven coke, or 10 pounds of Youghiogheny gas coke. The writer has no data from Omaha as to the value of tar when used with anthracite coal. The following results were obtained from Mr. W. H. Gartley, engineer of works at Philadelphia.

Mr. Gartley found that a gallon of tar was equal to 7 pounds of anthracite coal, and that not over .25 gallon of tar could be used efficiently when using anthracite coal. The data from Philadelphia, like that from Omaha, represents average values taken from results extending over a period of several years. Oil tar has been used as generator fuel with more or less success in Kansas City, Waterbury, Paterson and Yonkers. The writer has no data on this subject except from Omaha and Philadelphia.

As oil efficiencies are so variable under apparently uniform conditions we have been unable to determine definitely what the enriching value of tar is when used as generator fuel. It has an enriching value from the fact that by its use we are able to obtain better oil results than when no tar is used.

It will be seen from the analyses of samples of water gas taken at the bottom of the generator during a down run, with and without tar, that we have quite an increase in hydrogen, which reduces the percentage of carbonic oxide. Methane is increased by the use of tar. The fixed illuminants are unchanged, but the unfixed illuminants show by analysis an increase of 3 per cent. The chances are that the unfixed illuminants are much higher than shown, as it is impossible to determine accurately these constituents. They are certainly not less than shown, and doubtless much more. The appearance of this gas when burning would corroborate the above; that is to say, that the full amount of illuminants is not shown in the analysis.

The calorific value (calculated from analysis) of these two gases as taken at the base of the generators is as follows: Without tar, 309.16 B. T. U.'s; with tar, 342.20 B. T.

U.'s. If taken with the calorimeter it would probably be higher in the case where tar was used. The specific gravity of these gases at 60 degrees F. air = 1, as calculated from the analyses, is as follows: Without tar, .554; with tar, .456.

The average make per run, including all runs, is increased about 4 per cent by the use of tar. The saving in labor and boiler fuel by the use of tar is so small that it would not be worth considering.

As we make about .70 gallons of tar per 1,000 cubic feet of carburetted water gas, the importance of disposing of our tar to the best advantage should be emphasized, and while we cannot utilize all of our tar in our generators, it will be seen that we can use from one-third to two-thirds of our total make in this way, leaving the remainder to be disposed of in other ways.

If we utilize half of our tar in our generators, we should be able to dispose of the other half at a better price per gallon than we could obtain by selling all of our tar.

We must appreciate the value of our own product, if we want others to, and we must be able to utilize this product to advantage when we are unable to sell it at a fair price.

Other papers show ways of utilizing tar besides that of generator fuel, therefore it is not necessary for us to sell any of our tar. We can dispose of all we make in our own plant.

The uses to which oil tar can be put are so numerous that the writer does not hesitate to predict that the day is not far distant when a gallon of oil tar will purchase a gallon of gas oil.

Analyses of Uncarburetted Water Gas from Omaha, Neb.

	Without Tar in Generator	With Tar in Generator
Benzine vapor, C_6H_6	0.0	.3
Carbonic acid, CO_2	6.8	7.5
Illuminants	.5	.4
Carbonic oxide, CO	39.2	23.3
Oxygen, O_2	.5	.6
Hydrogen, H_2	50.0	60.4
Ethane, C_2H_6	0.0	.4
Methane, CH_4	.8	4.2
Nitrogen, N_2	2.2	2.9
	100.0	100.0
B. T. U.'s per cubic foot	309.16	342.20
Specific gravity air=1	.554	.456

The above samples were taken between fifth and sixth minute of an 8-minute run, hence high carbonic acid.

Analyses of Uncarburetted Water Gas from Philadelphia, Pa.

	Without Tar in Generator
Benzine vapor, C_6H_6	0.0
Carbonic acid, CO_2	3.0
Illuminants	0.0
Carbonic oxide, CO	42.8
Oxygen, O	.4
Hydrogen, H_2	50.2
Ethane, C_2H_6	0.0
Methane, CH_4	.4
Nitrogen, N_2	3.2
	100.0

The above sample was taken during whole run, showing the average composition of "blue gas" without tar in generator.

Analysis of Oil Tar from Omaha, Neb.

Sample of tar used in generator, 9-29-03.
Specific gravity, 1.1602.
Water, none.

Distillation Test.

Crude Products of Distillation	Per Cent. by Volume	Per Cent. by Weight	Sp. Gr.	Fractions
Light oils (below 338° F.)	8.3	6.12	.8733	Canary
Middle oils (338°–518° F.)	41.3	35.41	.9948	Ch Yel.
Anthracene oils (ab. 518° F.)	30.5	28.87	1.1018	Dk. Red
Residuum		28.96		
Total	80.1	99.36		

Note absence of water.

THE ECONOMY OF THE GAS ENGINE AS AGAINST OTHER POWER.

(A paper read by Mr. Wm. W. Welch at a recent meeting of the Natural Gas Association of America, held at Kansas City, Mo.)

At the present time and in this section of the country, with the use of natural gas just becoming general, the gas engine question is one of the most vital questions which presents itself to the gas man.

In the first place, the gas engine has just reached that point where we can say from experience that it is a success. For there are gas engines of all sizes which have proved beyond a question that they are satisfactory, satisfactory not only from the standpoint of the saving in fuel, but a saving in other respects also. There are engines in use today of sizes up to at least 1,000 horsepower, which from the standpoint of maintenance and low cost of operation are eminently successful.

The thing which now remains to be done is for those interested to investigate for themselves the condition of the gas engine business today.

Of course, there will continue to be improvements in design and construction, for a long time to come, and just as there is today and has been for many years past, improvement in the field of electric motors and even steam engines, but the idea which exists in the minds of some people that the gas engine is still in an experimental stage is a very much mistaken one.

It is a wonderfully fortunate thing for us who are connected with the natural gas industry today that the gas engine has reached its present state of development and it is also a fortunate thing for those users of power who are so situated that they can take advantage of the opportunity presented.

Before going to the comparison of the efficiencies of the gas and the steam engine, which is the limited scope that I have given to this discussion, let me jump to a few conclusions along this line, and show you where in the natural gas is an advantage to us as sellers of natural gas and also to the power user wherever the gas is within his reach.

It has been demonstrated that a power business is a necessity to a natural gas company doing a business of any magnitude.

With the power business to fall back upon, not only during the six summer months, but during the balance of the year or until the time comes when the domestic consumption on account of extremely cold weather increases to such a point that the capacity of lines furnishing the supply has been reached, satisfactory business results during all seasons.

With steam power business, it must be borne in mind that the rate is on an average just two-fifths of the domestic rate and the only reason you are selling gas at this rate is to keep your plant operating and your investment making a return during such time as you are not able to dispose of the gas at a higher domestic rate.

This low power rate which is made is a result of the necessity to compete successfully with a good grade of cheap coal. The power business, although it can be handled by the distributing company much cheaper than domestic business for the same amount of gas consumed, is not by any means as desirable as the domestic, if the domestic business rate can be secured. What I maintain and what I will endeavor to show you is this, that by diverting this power business from a steam engine business to a gas engine business, we will be able to secure from it the domestic rate for 12 months of the year, and although the seller of natural gas is getting a larger price for his gas to the extent of two and one-half times as much, the consumer of the gas or the power user is buying his power for just about one-half of the price he pays when he burns the gas under the boiler.

If the above statements which I have made are true, then it would seem that the matter would be one of vital interest to all concerned in natural gas, whether he be buying or selling gas for power or whether he be a domestic consumer, as any economy or saving in the use of gas will result in the longer use of it for domestic purposes, and a supply which might be ordinarily expected to last for 16 to 20 years, be prolonged for many more.

Before making the comparison I will briefly explain the difference between a boiler horsepower unit and an engine horsepower unit.

For either the steam or gas engine, the power unit is the same, that is, it is a measure of the rate of doing work and is called a horsepower, equivalent to 550-foot pounds per second; 33,000-foot pounds per minute, or 1,980,000-foot pounds per hour. A horsepower hour is the work done in overcoming a resistance for a period of one hour at the unit rate which is given above.

The power of an engine can be derived by several different means and it is a comparison of these means with which we are concerned at the present. The amount of energy required, however, to develop a horsepower differs, depending upon the type of engine, etc.

The quadruple expansion steam engine will develop a horsepower hour with a consumption of 10 or less pounds of steam, while a simple engine of a crude construction will require from 50 to 60 and sometimes more. A good gas engine will develop a horsepower hour with a gas consumption varying from 9 to 15 cubic feet per hour. It is my intention to show you the relative economy of steam and gas engines when both are reduced to the same basis of the number of cubic feet of gas consumed.

A boiler horsepower is the unit of the evaporative capacity of a boiler in a certain length of time, and does not represent the performance of so much work in the same sense as an engine horsepower—34½ pounds of water at 212 degrees F. evaporated into steam at the same temperature in one hour represents one boiler horsepower unit; the same thing can be expressed in a different form by saying that 30 pounds of water raised from a temperature of 70 degrees and evaporated into steam and the steam confined until its pressure had accumulated to 100 pounds, equals 1 horsepower.

The point which I wish to make clear is this—that if it takes 50 cubic feet of gas to develop a boiler horsepower, and if you are using steam equivalent to 200 boiler horsepower, it does not necessarily imply that you are getting 200 horsepower of useful work from your engine and that you are expending 50 cubic feet of gas per horsepower to do it. If your engine is consuming 34.5 pounds of steam, when reduced to a basis of "from and at 212," then the above will be true, but if your engine were using 38 pounds of steam instead of 34.5 then the horse power in your engine would be developed at an expense of 54 cubic feet of gas. If your engine were an economical one, and used only 25 pounds of steam, then the engine horsepower would only be costing you 35 cubic feet. So, clearly get in mind that a steam engine horsepower may be developed with a gas consumption which varies through a wide range, depending upon the type of engine.

The tests of the amount of gas consumed under a boiler to develop a boiler horsepower give practically the same results when the proper conditions are existing at the boiler, and from the results of numerous tests it is safe to assume that under favorable conditions 50 feet of gas will be required. The conditions are sometimes very much worse, and but seldom any better.

Taking into consideration some of the most economical steam plants of from 250 to 1,000 horsepower, where compound engines are used in connection with condensers, and other saving devices, it will be found that allowing for losses, due to steam piping, auxiliary pumps and other wastes, the steam consumption per indicated horsepower will not fall short of 25 pounds, and 28 pounds for brake horsepower. In such a case the gas consumption would be 40 cubic feet per brake horsepower at the engine. In exceptional plants, this condition might be bettered to the extent of 10 horsepower, or 15 per cent, and in the very large power plants still better results are obtained, but these are isolated cases and need not be considered in comparisons made here.

If your engine were of the high speed simple automatic type, your steam consumption would be about 38 pounds, all losses being taken into consideration and the gas consumption per brake horsepower 54 cubic feet, but if the engine were of the ordinary simple type, with possibly leaky valves, and piston rings, the steam consumption might be as high as 60 or 70 pounds. In this last case the gas consumption would be on a basis of 60 pounds of steam used, 85 cubic feet per horsepower.

Our results then are with the three foregoing types of engines, as follows: Compound engines under running conditions, 40 cubic feet of gas, automatic 54, plain slide valve 85.

It is with these figures that I will compare the performance of the gas engine and show the saving in fuel consumption.

But before going into the figures pertaining to the gas engine, I will show what the thermal efficiency is in the above case of the steam engine.

Taking first the case of the automatic engine where a horsepower hour is developed with a gas consumption of 54 cubic feet, we will assume that the temperature of the gas is such that there is no correction for temperature required. The only correction therefore is for pressure. In this calculation it may be assumed that the pressure of the atmosphere is such as to give a barometer reading corresponding to 14.5 pounds. With gas measured at 8 ounces, the multipliers to get the actual number of cubic feet of gas consumed would be 1.035.

In 1 cubic foot of gas there are 996 heat units. Therefore to develop 1 horsepower at the brake or belt of the engine there are required 53,784 B. T. U. The equivalent in work for 1 B. T. U. is 778 foot pounds, therefore the number of foot pounds represented in the above is 81,844,000.

The theoretical number of foot pounds in a horsepower hour is 1,980,000 and the actual thermal efficiency is 4.7 per cent. This means that of the actual heating value in the gas that 4.7 of it is being made use of to drive the belt of your shafting or do other work. This may seem startling, but nevertheless the facts remain, the points where the losses occur being many, granting that the consumption of gas in your furnace is perfect, that is, that all of the available gases are combined, during combustion with the proper proportion of oxygen to form carbonic acid gas and that no carbon monoxide is formed, there will always be more or less excess of air to be heated. This air with the carbon dioxide resulting from combustion and the nitrogen in the air, are heated from the temperature of the boiler room to the temperature of the stack, and the heat required to do this is wasted. Then come the losses from radiation of boiler, steam piping, condensation, etc., and finally there are the losses in the steam engine, first the theoretical or necessary losses, and second the unnecessary losses due to wear or improper construction, etc. After passing through this series of sieves but 4.7 per cent of the original quantity of heat is converted into useful work.

In the example just cited, I have taken the middle of the three cases. If I had taken the first, the thermal efficiency would have been 6.4 per cent, which is somewhat better, but if I had taken the third, 1.2 per cent would have been our result.

One does not realize what a wasteful combination is a boiler, a steam line, and an ordinary simple steam engine.

In the above statements in regard to steam engines, I have not gone into the relative economy at full load, half load, and no load, etc., as I have not intended to go into the performance of steam engines to such a depth, but rather to

show what the conditions are and the fuel consumption is in the ordinary everyday commercial use of steam.

Of course, I will grant that under conditions of test, when all leaks have been stopped and all other adverse conditions have been remedied, better figures will obtain, but in general, in a plant which has been in operation for a year or two, the figures as given will be found to be correct.

There are two general types of gas engine, the 4-cycle gas engine, discovered by Beau de Rochas, in France, in 1861 or 2, and developed later by Otto, and the 2-cycle or Clerk cycle. I will not enter into discussion of the 2-cycle engine here, except as I can in a few words to describe its operation and say that in this country it has not met with the favor that has been accorded the 4-cycle engine. In general I would say that the reason that the 2-cycle engine has not met with the same favor here is because it is more complicated in construction and does not give as great economy. In this type of engine, the operation is briefly as follows: There is an explosion every revolution, starting with a cylinder in which the piston is at the beginning of the stroke, with the clearance space filled with a compressed mixture, the explosion takes place and the working or expansion stroke of the engine is passed through. The pressure generated by the explosion is expanded to the pressure of the release, the exhaust valve opens and part of the burnt gases pass out. The piston reverses its direction of travel and commences pushing out the balance of the burnt gases. Shortly after the beginning of the return stroke, the inlet valve opens and a charge of pure air is admitted. This is followed by a charge of partially compressed explosive mixture, which has been compressed in an auxiliary cylinder or pump attached to the engine. The layer of pure air advances in front of the compressed charge, which in turn is followed by the piston, and the burned gases are driven out. At a certain point in the stroke the exhaust parts are covered by the piston, the inlet valves are closed, the compression is completed by the piston traveling to the end of its stroke and the cylinder is again ready for an explosion. In some makes of engine of this type the pure air is omitted with a resulting loss of economy.

In the 4-cycle engine the process is somewhat different, although the result is the same. The compressed mixture in the cylinder is exploded and expanded and the work of the engine done during the expansion stroke. On the return stroke the burned gases are swept out by the piston passing through the cylinder; on the next stroke in a forward direction a new charge is admitted at practically atmospheric pressure, and on the second return stroke this charge is compressed to the pressure desired before the explosion; thus the 4-cycles are completed and the engine is in a position to repeat the same. The thermal efficiency of the gas engine varies, depending upon the type and upon the relative dimensions of the engine, but the amount of compression and the extent to which the expansion is carried are the important factors in determining the efficiency. The explanation of the conditions wherein 100 per cent efficiency is an impossibility lies in the thermo dynamic discussions of the gas engine, which we will accept here. That wastes occur and that the efficiency is reduced can readily be seen from the fact that large amounts of energy are carried off by the exhaust gases in the form of both pressure and heat. The thermal efficiency is also diminished by the loss of heat which is carried off in the jacket water.

The indicated horsepower is what we get, taking into consideration solely the thermal losses. There is still another loss in a gas engine or in any engine, the friction loss expressed by stating that the engine has a certain mechanical efficiency. After both the thermal efficiency and the mechanical efficiency are considered we arrive at the brake horsepower of the engine. All comparisons of engines should be made on the basis of brake horsepower, as in that case the varying mechanical efficiencies of engines would be credited to the engine or charged against it in their true amounts. Speaking generally, the theoretical thermal efficiencies, and with a mechanical efficiency of from 85 to 90 per cent, we get a resultant efficiency of from 30 to 40 per cent.

In actual practice we get efficiencies in the large units as high as 28 per cent and 30 per cent, and in smaller units of 15 to 25 per cent, depending, of course, upon the type of engine and the care exercised in their construction and operation.

Large units with double acting cylinders arranged in tandem, where there is but one reciprocating mechanism, give a higher mechanical efficiency than a series of two or more single acting cylinders arranged in parallel, each with its own set of reciprocating parts. In some of the large, modern multiple cylinder engines we are getting to-day a brake horsepower hour with a gas consumption of 9 cubic feet of gas reduced at atmospheric pressure.

Making a summary of our results we have as follows:

Gas Engines.	Efficiency. Per Ct.	Gas Consumption. Cu. Ft.
A. Compound steam engine plants	6.4	40
B. Automatic simple steam engine plants.....	4.7	54
C. Simple slide valve engine plants less than..	2.0	85

Gas Engines.	Efficiency. Per Ct.	Gas Consumption. Cu. Ft.
A. Large multiple cylinder gas engine plants..	28	9
B. Medium gas engine plants	20	12 8
C. Small gas engine plants	15	17 1

Comparing class (A) of steam engines with class (A) of gas engines we have a ratio of 1 to 4.25 in favor of the gas engine. Comparing class (B) we have a ratio of 1 to 4.2, and in class (C) we have a ratio of 1 to 4.9. Reducing our figures to cost of power, and taking into consideration the different gas rates, we got a saving of almost 50 per cent in practically all installations.

The repairs on gas engine plants (and I only refer to high grade gas engines) are very much less than on steam boiler and engine plants, and the operating expenses of the gas engine plant show as great a percentage of saving as the fuel end of the question.

NEWS NOTES.

A franchise has been granted H. P. Clark, as trustee of a proposed company to be formed in Salt Lake City, to construct and operate an electric interurban railroad through that city. Construction work is to begin immediately, and it is expected that it will be completed within eighteen months. By the terms of the franchise, the city is to receive 1½ per cent of the gross earnings, during the first five years, of that portion of the road within the city limits, and 2 per cent per annum after five years, with $1,000 fixed as the minimum amount which the city will receive annually. The chief promoter of the enterprise is W. G. Purcell, of Los Angeles.

Ernest L. Godbe, of Salt Lake City, has filed two applications with the State Engineer, each for the appropriation of 54 second feet of the water of Coyote Creek, in Garfield County, Utah, for the purpose of generating electric power to be used in the Coyote mining district. The proposed plants are each to operate under 75 feet of head.

Anaheim, Cal.—A. L. Roach is making preparations to improve his 320 acres. A pumping plant will be installed and 100 inches will be developed for irrigation.

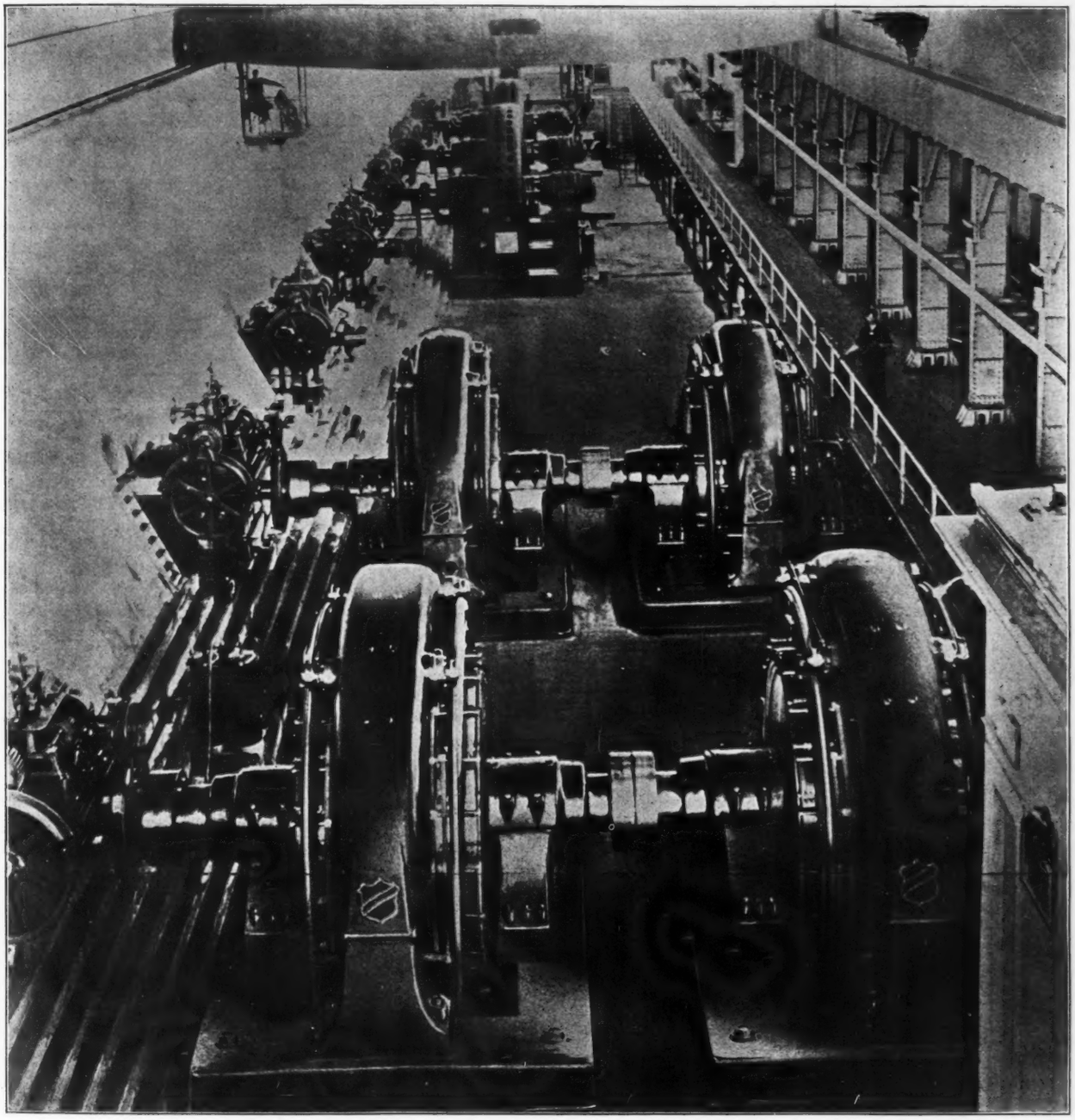
Placerville, Cal.—Chas. Sharp claims 150 inches of water flowing in Ponobscot creek for mining purposes.

MASSENA POWER HOUSE OF THE ST. LAWRENCE RIVER POWER CO.

Massena, N. Y., is the site of an electric power plant of 20,050 kilowatts capacity, operated from water power derived from discharging water from the St. Lawrence into La Grasse river through a canal about three miles in length. St. Lawrence county is the largest in the state and second only to Niagara in its water-power resources. It leads all other sections in the extent of its mineral deposits. Along its northern boundary the St. Lawrence river flows for 73 miles, passing down Galaps, Du Plats and Long and Little Sault Rapids in its course. The last-named rapids represent a fall of nearly 50 feet in the river along ten miles of its course.

The plant at Massena is located more than a hundred miles away from any of the larger cities of the state, and is in the midst of a territory rich in natural resources. The company in control of the plant has chosen to build up a manufacturing center about it, and to supply energy at favorable rates to industries only a few miles distant rather than to undertake long transmissions of power. Some of the reasons for this policy may be found in the fact that St. Lawrence county offers an attractive field for the manufacture of paper from wood pulp, and contains large deposits of magnetic and hematite iron ore, and of white and blue marble.

In accordance with their policy, nearly one-half of the present capacity of the electric station is devoted exclusively to the development of energy for the nearby works of the Pittsburg Reduction Co. The accompanying illustration shows a view of the power house interior, in the foreground of which may be seen four Allis-Chalmers type "HI" generators, each rated at 2,200 kilowatts, 500 volts, direct current, which supply the power required, and are kept in operation 24 hours per day and seven days per week, with very short intermission for inspection and repairs. Each pair of these generators is direct connected to the shaft of a single set of horizontal turbine water wheels.



POWER PLANT OF ST. LAWRENCE RIVER POWER CO.

The output from the four generators is transmitted from the water-power station to the works of the Pittsburg Reduction Co. over conductors which have a single length of about 1,500 feet, and are probably among the largest in the world. Each side of the two-wire 500-volt circuit which carries this current of 17,600 amperes, is composed of a number of large flat bars of aluminum to a point a little outside of the power house, when it changes to 250 round aluminum wires, each having a diameter of ⅜ inch. For the support of the two conductors like those just described there are two parallel pole lines with cross timbers between opposite poles, and the aluminum conductors lie directly on the wood at every support. An examination at one or two points failed to show any signs of charring in the wood next to the aluminum wires, and it was stated that no trouble had developed from this cause.

In the works of the Pittsburg Reduction Co. the greater part of the energy represented by the 500-volt current is used in the production of aluminum, but quite a large portion is consumed as power in the wire drawing mill. Though aluminum is produced at other points by the Pittsburg Reduction Co., it is said that all the aluminum wire which is made in the United States is drawn at the Massena plant.

A NOVEL EXPERIMENT.

The Southern Pacific Company is again to the front with one of the most novel and radical departures yet made in railroad work. Under the direct supervision and auspices of the University of Nevada, a technical school will be opened in the railway school building near the library in Sparks.

For sometime past President Stubbs has been negotiating with Supt. Dunn for the purpose of extending the University work. so far as its practical departments and mechanical work is concerned. These negotiations have resulted in the enlargement of this department, which is directly under the charge of Prof. J. G. Scrugham, by the establishment of a technical school for railway employes at Sparks. And, by order of Supt. Dunn, the railway apprentices who attend this school will receive full pay for time spent in the school on the same basis that they would be paid if working in the shops.

This is the first known instance in which a railroad company has provided education and paid its men for acquiring it.

This is believed to be the first effort ever made along these lines by any railroad in the United States. It is a recognition by the railroad company of the principle that better education and particularly special education is productive of better and more efficient work, and it is on a basis of increased efficiency that the railroad hopes to receive an equivalent for the cost of the experiment. President Stubbs, the University professors, President Harriman and the railway officials certainly deserve the highest praise for the introduction of this commendable project. The work of the school will be watched with special interest all over the country, and the city of Sparks may pride itself on being the birthplace of this new educational enterprise.

The school will be under the charge of Professors Scrugham, Baker and Freeman, of the University. The courses which will receive special attention are arithmetic, elementary mechanics, mechanical drawing, link motion and valve gears. There will be two classes established; one for apprentices will be held every Monday and Tuesday morning from 7 to 9 o'clock, and the other for machinists, car men, mechanics, etc., will be held every Monday and Tuesday evening from 7 to 9 o'clock.

All the shop foremen have been consulted by the professors as to the courses to be taught and the special lines of instruction to be taken up, the plan being to make the instruction result in the acquirement of useful and practical knowledge of a working value to the students. The record of each student will be carefully kept, and reports will be regularly made to the railroad officials who will pass them up to Supt. Dunn, showing the progress being made by the students. In this way, also, the students will have the opportunity to bring their merits to the direct attention of the railroad officials. The idea is full of merit in every particular, and it will be strange if there is not a large enrollment, as practically all the railway employes at Sparks are eligible. The project also confers great credit on the enterprise of the mechanical department of the University.

THE ELECTRIC CURRENT AS A WATER PURIFIER.

In a letter to the director of the Department of Public Works, Philadelphia, Pa., Mr. W. W. Gibbs, president of the United Water Improvement Co., gives some interesting figures on the results obtained in the use of electricity, for removing bacteria from large quantities of water. Tests have been made at a plant having a capacity of one million gallons of water per day. Bacteriological examination showed that the raw water of the Schuylkill river at a certain point contains as high as 2,500,000 bacteria per cubic centimeter, after a rough straining, to remove the coarser particles of suspended matter, the water contains from 253,000 to 700,000 bacteria; after ozonization it contains about 5 to 55.

The process of ozonization is electrical, current at 100 cycles and 10,000 volts being employed. By the use of inductance coils and condensers, numerous discharge points assist in the formation of pencils of blue light. Atmospheric air, which is drawn across these points by means of an air pump, is thus converted partially into ozone. The ozonized air is then forced through a standpipe in which it meets a current of water flowing in the opposite direction. The contained bacteria are destroyed by the ozone. It is stated that about 200 kilowatt hours of electrical energy are required for each million gallons of water treated.—"Electrical World."

FIRES NOT CAUSED BY ELECTRICITY IN GERMANY.

Electricity has often been accused of causing fires, but this has not been the experience of Herr von Moltke, who considers that the danger is infinitesimal if the electrical installation has been carried out in accordance with the recognized rules. The total loss through fire in Prussia in the years 1900, 1901, 1902, and 1903 amounted to ninety-seven, ninety-two, seventy-six, and ninety million marks respectively, and of this only two, two, one, and one and one-half million marks respectively are officially ascribed to electrical causes. Even this small percentage would probably be reduced by careful investigation.

It has often been suggested that the overhead wires of electric tramways, etc., would give trouble in case of fire, and elaborate precautions for disconnecting these in case of need have been insisted on by the police in certain towns. An inquiry addressed to thirty-eight German towns asking whether this disconnection has at any time been necessary has been replied to in the negative in every case except that of Hamburg. The same inquiry sheet elicited the fact that death or serious injury has never been caused to anybody at a fire in these towns through electrical installations, in spite of the fact that a number of personal injuries of various kinds occur at almost every important fire.

With regard to danger of shock to firemen through squirting high-tension mains, experiments have shown that this is a real danger, but at the same time extremely little damage has resulted from this cause, chiefly owing to the careful instruction given to the firemen. This instruction often includes particulars of all the electrical installations in the town as well as notes as to the avoidance of shocks, and as to the first aid to be given to persons suffering from electric shock.

The JOURNAL OF ELECTRICITY
POWER AND GAS
WITH WHICH IS INCORPORATED
The Engineers' Architects' and Builders' News

Published Weekly by

The Journal of Electricity Publishing Company
304 Atlas Building, San Francisco.

Yearly subscription, $2.50. Single copies, 10 cts. Foreign subscription, $3.50 Subscriptions cannot be begun with back numbers. Manuscripts submitted must be accompanied by postage to insure return.

Address all communications and make all remittances payable to the Journal of Electricity Publishing Company.

EASTERN AGENCIES:
NEW YORK
CHICAGO
ST. LOUIS

WESTERN AGENCIES:
LOS ANGELES
PORTLAND
SEATTLE

Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," with which is incorporated "The Engineers' Architects' and Builders' News."
Entered as second-class matter at the San Francisco Post Office, August 15, 1899.
Entered as "The Electrical Journal," July, 1895.
Entry changed to "The Journal of Electricity," September, 1895.

VOL. XVII SEPT. 29, 1906 No. 13

EDITORIAL.

THE CONSULTING ENGINEER AND THE INVESTOR

Not often is it necessary for a consulting engineer to refuse to serve a municipality on account of the fact that were he to serve it would be necessary for him to make a report at variance with his best and truest judgment, after carefully investigating and analyzing the conditions underlying the engineering problem under consideration.

It probably more often happens that a reputable consulting engineer finds it necessary for the same reason to refuse to serve either private individuals or corporations. Invariably prospective investors desire the services and the advice of the best engineers available and rightly expect that their reports will contain all the conclusions and recommendations which the conditions of the particular investigation require.

In the early stages of the development of many enterprises three types of men are usually involved, viz., the promoter, the consulting engineer and the investor. The engineer is usually a scientifically trained man with engineering knowledge and experience. The investor is ordinarily a business man, banker or capitalist. It is not, however, easy to define the function of the promoter. It would seem from the experience of the past few years that promoting is a combination of science and an art. The field of the promoter is perfectly legitimate, and he deserves, if his work is straightforward and as it should be, proper financial reward. Often, due to his insight into the conditions existing or possibilities resulting from new development, he in effect creates a new enterprise of great importance and lasting value, and capitalists or investors find in the straightforward and honest promoter a valuable associate. It is natural, however, for the investor to depend more upon the consulting engineer than upon the promoter to furnish him with the facts regarding, and estimates of the probable value of, the proposed new venture.

At the present time, the city of San Francisco is much in need of an adequate domestic water supply. There can be no question that such a supply is available. Investigations have been carried on for many years in order, if possible, to determine the best of the many sources of supply. San Francisco, therefore, stands today in the position of the investor. The advice, counsel and recommendation of competent engineers is certainly advisable. There are a great number of sources of water which may be purchased and the systems developed. It can hardly be said that such water sources are in the hands of promoters, but they are certainly controlled by men whose present position does not differ materially from that of the promoter in many cases.

If a private corporation were in the position of the city of San Francisco, such a corporation no doubt would most carefully investigate the problem from every standpoint before making a definite decision. Such a corporation would undoubtedly secure the services of the best and most reputable engineers available and they would expect such engineers to give them a complete report after making a thorough examination of the situation.

Where private enterprises are involved, it is almost unthinkable that the promoter and investor would stand together as against the consulting engineer. If the present situation regarding the proposed water supply of San Francisco, however, is in fact in accordance with the general information which is being given to the public, it would seem that this is exactly what is happening at the present time, and it would also seem that the consulting engineer, in order to save his reputation, which is always his most valuable asset, finds it impossible to serve the city, which in this case is the investor, because those responsible for the city's interests are not really representing the best interests of the people.

We hear a great deal of discussion regarding the advisability of the municipal ownership of public utilities. It is a question yet unsolved in the United States whether it is possible for the public to own and operate its utilities in as satisfactory a manner as can be done by private ownership. Certainly the most able engineers are not as often connected with the municipal enterprises as they are with the private corporations. Is it not probably true that the great weakness and cause of many failures in municipal ownership is due to the unsavory political conditions surrounding the technical direction and management which are so well illustrated in the present water supply situation in San Francisco?

BOOK REVIEWS.

The proceedings of the delegates of the Counties Committee of the California Promotion Committee at their semi-annual meeting held in Napa on June 16 is contained in that organization's Bulletin No. 3. The next meeting will be held on December 15, 1906, at San Diego.

The United States Standards for screws, bolt-heads and nuts have been found unsatisfactory for the best construction of fine machinery. In order to eliminate the confusion and inconvenience which would necessarily follow if special dimensions were used by each manufacturer, the Association of Licensed Automobile Manufacturers has adopted a new screw standard. The specifications are fully given in their Bulletin No. 18. Where the screws are to be used in soft materials the pitches are the same as for the United States Standard.

WATER POWER DEVELOPMENT IN WISCONSIN.

"Much interest is shown at the present time in water power development in the state of Wisconsin," says a bulletin issued this month by Chief Hydrographer Leighton of the United States Geological Survey. "A single firm of engineers has received during the past year over thirty applications from clients for preliminary plans for water-power plants. Many of these projects contemplated the transmission of power a considerable distance by electricity. The United States Geological Survey, which is measuring the flow of streams in all parts of the country, is carrying on in Wisconsin as much work as the available funds will permit. Surveys of streams are being made in co-operation with the state, and river gauging stations are being maintained at the following points: Black river, at Neillsville; Chippewa river, at Chippewa Falls and Eau Claire; Flambeau river, at Ladysmith; Oconto river, at Gillett; Preshtigo river, at Crivitz; Wisconsin river, at Merrill; Necedah and Rhinelander and Wolf river, at Shawano."

BELT VERSUS ROPE TRANSMISSION.

Professor Kammerer of Charlottenburg has, we notice, been making a series of experiments in order to determine the respective efficiencies of belt and rope transmissions. The results of no less than 2,000 tests are relatively favorable to the transmission of power through belts. Many special instruments and arrangements were employed during the course of the experiments, which have extended over several years. Further tests with different materials are to be made. Their importance is greater than may at once appear, since to many manufacturers the cost of belt renewals is a very large item, and the maintenance charges may be as heavy as the outlay for fuel.

THE USE OF WATER IN THE COMBUSTION CHARGE OF CRUDE OIL ENGINES.

Injecting water into crude-oil engines has been known for some time to result favorably as to the economical operation of such engines and also to increase the power obtainable from a cylinder of given size when the water is delivered in addition to the oil into the vaporizer and cylinder. It is well established that with water injection much higher compressions are possible without danger of pre-ignition. The claim is also made that water injection lowers the temperature during the suction stroke and thus increases the weight of the charge drawn in. The increased efficiency of engines with water injection is held by Robert F. McKay in a discussion of the subject in "Engineering" to be attributable to the chemical reaction which takes place between the carbon residue and steam at the very high temperature to which they are subjected.

A CURIOUS OBJECTION TO OVERHEAD WIRES.

It appears that after carefully watching for three years a kilometer's length of telegraph wire in a district not overpopulated with birds, an interested observer has proved that 1½ head of game, such as partridges, pheasants, quail, and so on, are impaled yearly on every wire of this length in France, which means a total all over the country of 40,000 annually. Many of the victims, especially of the migratory kind, lose their lives through nocturnal flights. In view of these conditions sportsmen in France are strongly in favor of space telegraphy and are advocating its adoption as one of the most valuable game laws.

TEST OF A PRODUCER GAS ENGINE PLANT.

A producer gas engine plant in the municipal lighting station at Algona, Iowa, has been tested by the mechanical engineering department of the Iowa State College. The engine is a 3-cylinder vertical machine rated at 150 brake horsepower at 250 revolutions per minute. Anthracite pea coal was used at the rate of 1.511 pounds per brake horsepower when the engine was developing at 40.1 horsepower; 1.157 pounds at 82.7 horsepower, and 0.999 pound at 156.9 horsepower. This is equivalent to a fuel charge of 4.53, 3.47 and 2.99 mills per brake horsepower, with coal at $6.

POWER TRANSMISSION IN BRAZIL, SOUTH AMERICA.

The city of Nichtheroy, some 30 miles north of Rio de Janeiro, South America, has given its name to a new electric transmission system for supplying power and light to the towns of Cascatinha and Mage, as well as to the title city. Electricity is to be generated by water power and transmitted at 44,000 volts to substations at the cities mentioned. The installation is representative of the most modern engineering. At the main generating station the initial equipment will comprise three, three-phase revolving field, 2,000 kilowatt generators and two 75 kilowatt exciter sets, to be driven by water wheels. The excitation current for the main generators will be furnished at 220 volts, the generator voltage being 2,300. This voltage will be stepped up to 44,000 volts in a bank of six water-cooled transformers, each having a capacity of 1,000 kilowatts and operating at 60 cycles. There is to be a spare 1,000 kilowatt transformer and a 3,000 kilowatt generator as a reserve. A very complete switchboard will be installed, all switches as well as rheostats being electrically operated from the board by remote control so that there will be no high tension wiring at the switchboard. From the main generating station the power is to be delivered over a steel tower line to the three substations named in the foregoing. At the substations the transmission voltage is to be reduced to 6,600 volts for the local delivery. For this purpose there will be four 750 kilowatt transformers at Nichtheroy and four 350 kilowatt transformers at each of the other stations, Cascatinha and Mage. In each station one of the four transformers will be installed as a reserve.

ELECTRIC SMELTING IN CANADA.

In a preliminary report on the experiments made at Sault Sainte Marie under Government auspices in smelting Canadian iron ores by electrothermic processes, Dr. Haanel, Superintendent of Mines, states the cost of production per ton of pig-iron by electric process to be $10.69, and that the estimated cost of a 10,000-horsepower plant producing 120 tons of pig-iron per day of twenty-four hours would be $700,000.—"Electrical Review."

The Los Angeles Gas and Electric Company is building the largest gasholder in the Far West. Its capacity is 5,019,000 cubic feet, and it will be completed by Fall.—"American Gas Light Journal."

FINANCIAL.

San Francisco, Cal.—From time to time during the past three months there have been rumors to the effect that some sort of a merger or reorganization scheme was contemplated with reference to the Spring Valley Water Company. About two months ago a holding company was organized by some of the leaders of the Realty Syndicate of Oakland for the purpose of acquiring control of the Contra Costa Water Company. The Contra Costa Water Company is now practically under the control of the Realty Syndicate. Shortly after the change was announced as nearing completion, there was some liberal buying of Spring Valley shares. This gave rise to the belief that the Realty Syndicate was reaching out for the control of the Spring Valley Company, which would give it absolute control of the water supply of San Francisco, Oakland, Alameda, Berkeley and several other small towns in Alameda and Contra Costa Counties. A few weeks after the fire Spring Valley stock sold as low as $18.25; previously it had stood at $42.50. With the recent $3 assessment due on October 1st, 230 shares have sold at $21.50, and there are more buyers than sellers in the market. Persistent buying and steady advance indicate that some such movement as the accumulating of large blocks is in progress.

Los Angeles, Cal.—A circular letter has been sent to the stockholders of the Union Oil Company by President Lyman Stewart. It states that so far the company has earned for its stockholders the sum of $2,225,000, which has been distributed as dividends upon a capitalization of $10,000,000.

San Francisco, Cal.—A statement has been made on the authority of one of the leading brokers of California street that about all of the 3 per cent of the bonds of the United Railroads are now in the possession of local capitalists. Of the original issue of $20,000,000 of bonds about $12,000,000 were subscribed here, and the balance taken for speculative purposes by some of the big New York firms.

San Francisco, Cal.—A monthly dividend of five cents per share on the issued capital stock of the Northern California Power Company has been declared payable by mailed check.

Los Angeles, Cal.—President H. E. Huntington, of the Pacific Electric and the Los Angeles Railway Companies, has voluntarily increased the rate of wages of conductors and motormen on all his city and suburban lines to a substantial extent. The Los Angeles-Pacific Railway Company also has announced an increase in the wages of motormen and conductors, which becomes effective October 1st.

INCORPORATIONS.

San Jose, Cal.—The Sunnyvale Water Company has been incorporated. The capital stock of the company is $100,000, subscribed by J. H. Hendy, C. C. Spalding, F. J. Behneman, F. J. Fewings, and W. E. Crowman.

San Francisco, Cal.—The Sierra Mercantile Mining and Power Company has been incorporated. The capital stock of the company is $50,000. The incorporators are H. A. Moss, M. H. McCord, J. E. Fagothey, R. W. Gillogley, and R. Phelan.

San Francisco, Cal.—The Merced Falls Gas and Electric Company has filed incorporation papers at this place. The capital stock of the company is $250,000, and the directors are Geo. Crocker, C. E. Green, J. D. Bradley, A. F. Morrison, and C. H. Shaw.

Santa Maria, Cal.—The California Newlove Oil Company has filed articles of incorporation, the directors being I. N. McGuire, H. J. Abels, R. Manderscheid, E. A. Newlove, and Frank Newlove.

Los Angeles, Cal.—The Walnut Grove Mutual Water Company has been incorporated. The capital stock of the company is $50,000. The directors are Elizabeth Roberts, Clifton Axtell, G. A. Nehrhood, H. J. Duff, and E. W. Riggle.

Salt Lake, Utah.—The Light, Power and Water Company, of the new town of Elgin, on Green River, has filed its articles of incorporation. The capital stock of the company is $24,000, and the officers are L. P. Hill, president; W. G. English, vice-president; C. E. Whistler, treasurer and general manager. The company is to divert water from Green River for power and irrigation purposes.

TRANSMISSION.

Marysville, Cal.—The Northern Electric Company has changed its plans as to the building of a sub-station on the Stocking place, in Sutter County, to supply power for its railroad, and has arranged to build it on the east side of G street, a few feet south of Fifth in this city. Brick taken from the buildings now being razed in Yuba City is being hauled to the site, and will go into the construction of the sub-station, which will be about 25x30 feet in size. The power line that was to be built along Ninth street and across the Feather River will be built, but the line will run further north to another point where there is to be a sub-station.

Rhyolite, Nev.—J. M. Willard, of the Western Gas Engine Company, of Los Angeles, will open an office here and put in a demonstrating plant on the corner of Main and Broadway. He will have a 25-horsepower hoist.

Santa Ana, Cal.—The construction of a sub power station of the Pacific Electric Railroad at Santa Ana is a certainty. Part of the machinery is on the ground, and plans for the permanent power house are out, but it will be some time before the building is erected.

TELEPHONES AND TELEGRAPHS.

Stockton, Cal.—An investigation is being made of the existing conditions in the telephone business here. The Pacific States Telephone and Telegraph Company has decided to spend $300,000 on toll lines in this State, and much of this amount will go into additional wires, between Stockton and San Francisco. Two new wires will be strung between here and the bay. Angels and Sonora will have another 300-pound copper loop, and an underground system will be constructed in Stockton.

Reno, Nev.—The Sunset Company will probably build a long distance telephone line from Wadsworth to Lovelock, connecting with these two cities all intervening points of interest.

San Francisco, Cal.—The California Supreme Court has rendered a decision in the case of the Western Union Telegraph Company against the city of Visalia, which does not make it necessary for the Western Union Telegraph Company to gain franchises from cities and towns through which its lines run, and if a franchise is obtained it is not assessable under any State law. The city of Visalia wanted the telegraph company to pay a tax of $30 on the franchise, and in order to obtain it determined to sell the poles and wires to make good the amount. A restraining order was obtained by the Western Union Company, and the matter was carried to the courts.

OIL.

Santa Barbara, Cal.—The La Graciosa Oil Company has let the contract for the construction of a pipe line from its property near Careaga, in this county, to tidewater, nearly 60 miles, and for a refinery, the cost of which being $1,500,000.

Tonopah, Nev.—The Standard Oil Company is preparing to build a large oil storage plant in this town and in Goldfield. The contract for the plant has already been let and requires that the buildings and tank foundations be completed within thirty days.

WATERWORKS.

Greenwater, Death Valley, Cal.—The Death Valley Copper Company of which F. A. Keith is president, is preparing to develop water at its mines. Wells are to be sunk, and there are prospects of getting water at 300 or 500 feet. Another plan is to obtain water from Ash Meadows. It is intended to put a pipe line leading from the Meadows. Two pumping stations will be necessary in lifting water to destination.

Santa Ana, Cal.—The Townsend-Dayman Company, which recently purchased 1,700 acres of the Irvine Ranch, has begun boring for water for the tract. A well-boring outfit is now at work and several wells will be sunk. A large pumping plant will be installed, and the water piped over the entire tract.

San Francisco, Cal.—The Bay Cities Water Company's project to supply San Francisco from the high Sierra lakes, the South Fork of the American River and the North Fork of the Cosumnes River, with a daily minimum of 60,000,000 gallons of pure water, capable of increase to a daily minimum of 200,000,000, sufficient for a city of 2,000,000 people has been chosen by the special water committee of the Board of Supervisors for recommendation to the Board at its next meeting. The company offers its present water and power rights in the Sierra, its present plant, and to complete the same so that it can deliver the amounts above set forth at the point of departure of the pipe lines across California's basin to San Francisco for $10,500,000.

Anaheim, Cal.—H. Dyer has disposed of his gasoline engine to the Edison Company, and will install a 25-horsepower motor at his pumping plant at North street.

Red Bluff, Cal.—A water appropriation has been filed by J. A. Whitehead for 40,000 inches of water flowing in Battle Creek. Water will be used for generation of electric power irrigation, and it is intended to build a canal.

ILLUMINATION.

Los Angeles, Cal.—The Edison Electric Company has donated a $1,000 steel tower for park purposes to the city council. This was given to the Park Commissioners in consideration of granting the Edison Company the privilege of maintaining steel towers in Griffith Park for the purpose of carrying the wires that will bring power from the Kern River.

Palo Alto, Cal.—At a meeting of the Board of Trustees, plans for the $50,000 water and light plant were submitted by Architect Branson. On their approval bids will be called for.

Ogden, Utah.—The Utah Light and Railway Company is preparing to improve the lighting service of the city by the addition of a sub-station.

Pasadena, Cal.—Development of power for the municipal electric lighting plant by utilizing the water at the Sewer Farm, is a plan that has received endorsement of leading engineers of the Coast.

Lompoc, Cal.—The Council has accepted the bid of $60,500 of Beard, Cobloth & Heller for a franchise for an electric lighting system. They promised to have the plant completed within six months.

Whittier, Cal.—The management of the Whittier Gas Plant is rebuilding and enlarging its plant and will put in a gas holder of five times the present capacity.

Gardnerville, Cal.—The Truckee River General Electric Company, which supplies light and power to Reno, Carson, Virginia, Sparks and several other Western Nevada cities, will begin at once the extension of its lines to Gardnerville. Plans were under way to erect a large generating station on the Carson River to supply this place and Minden, but the local capitalists were induced to abandon the plan by the Truckee River Company.

Prescott, Ariz.—The city is contemplating the establishment of its own lighting plant, and engineers employed by the city have reported favorably on the plan.

Chihuahua, Mexico.—Geo. E. Voorhees, Jr., of Santa Barbara, Cal., owner of the Las Vegas mine, near Coyame, has decided to install a gas producer plant to furnish power for the mill and mine.

Anaheim, Cal.—Vineyard lot G3, containing four acres on Los Angeles street, south of Santa Ana street, has been purchased from J. Frowenfeld, of San Francisco, for $1,200. The new city power house will be erected thereupon.

HALLIDIE MACHINERY CO.

Engineers and Machinery Merchants

Machine Tools, Foundry Equipment, Wood Working Machinery, Special Machinery

Main Office 315-317 Second Ave. South, Seattle.

Branch Office 502 First Ave., Spokane, Wash

WESTON Illuminated Station Instruments

These instruments are constructed upon the same general principle as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger and the working parts are inclosed in a neatly designed dust-proof cast iron case which effectually shields the instrument from disturbing influences of external magnetic fields.

Weston Electrical Instrument o.

Main Office and Works: *Waverly Park, Newark, N. J., U. S. A.*

New York Office: 74 Cortlandt St.

LONDON: Audry House, Ely Place, Holborn.
PARIS, FRANCE: E. H. Cadiot, 12 Rue St. Georges.
European Weston Electrical Instrument Co., Ritterstrasse. ss.

For Sale at a Bargain

Delivery after October 15th,

One 100 K. W. belted type National three phased 2200 volt alternator, revolving field, speed 1200 with sliding armature, built to order January, 1904, with exciter and switchboard panel which carries two ammeters, voltmeter, arc leg G. E. plug switches, 2500 volt 3 phase switch, exciter rheostat and two static ground detectors. Also one McEwen high speed 12 x 12 simple engine now running same which developed last winter on peaks 178 Ind. H. P. The entire equipment is in perfect working order, running continuously without shut down from sunset Sundays until sunrise following Sunday. Machinery being displaced by 60,000 volts from Spokane.

If you need an auxiliary for your plant

This is your Snap

Palouse Light and Power Company

PALOUSE - - - WASHINGTON